

Determination of the Activity of Lead-210 in Sediments and Soils

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1.0 Theory

Geochronology with the naturally occurring Pb-210 is based on the principle that the isotope has been continuously delivered to the earth's surface and undergoes continuous radioactive decay following incorporation into steadily accumulating sediments. The activity of Pb-210 in sections from sediment cores taken from lakes is used to determine the rate of that sediment accumulation with time. In this method the activity of the Pb-210 granddaughter, Po-210, is actually measured, as Pb-210 is a weak beta emitter and is not readily detected. Po-210 is the alpha emitting granddaughter of Pb-210, and can be used to represent the actual Pb-210 concentration in each sample because the two isotopes are assumed to be in secular equilibrium. The daughter is used because in an acidic solution it will spontaneously plate on to a copper disk, which can then be counted on a high resolution alpha spectrometry system. A yield monitor, Po-208, is added to each sample so that the exact activity of Po-210 can be determined.

Sediment cores are collected with a gravity or box corer. The samples are extruded at known intervals, usually 1-2 cm, and placed into preweighed bottles. The bottles are weighed again and placed in a 60°C oven and dried to constant weight. The difference in wet and dry weight is used to calculate the porosity of the sediment. The samples are then ground to a fine powder and stored until used.

2.0 Counting

The Po-210 and Po-208 concentration on each disk is determined by alpha spectrometry using silicon surface barrier detectors and a multi-channel analyzer system. The disks are counted in vacuum chambers to enhance the resolution of the Po-210 and Po-208 alpha peaks. The outputs from the silicon detectors are amplified and transmitted through a multiplexer system into a computer based multi-channel analyzer. The Po-210 and Po-208 peaks are displayed on screen across a 4000-6000 Kev energy spectrum, separated by cursors and recorded. The relative concentrations are determined from the number of counts within each region of interest, the counting time is 60,000 sec. The concentration of Pb-210 at the time of sediment sampling is calculated from the count rates corrected for counting background, growth and decay, counting efficiency and recovery of the Po-208 yield monitor.

3.0 References

Robbins, J.A. and Edgington (1975). Determination of recent Sedimentation rates in Lake Michigan using Pb-210 and Cs-137. *Geochim. Cosmochim. Acta.* 39, 285-304.

Robbins, J.A. (1978). Geochemical and Geophysical Applications of Radioactive Lead. In: J.O. Nriagu (ed.), *The Biogeochemistry of Lead in the Environment*, Elsevier/North-Holland Biomedical Press New York, N.Y. pp. 285-393.

4.0 Digestion

- 4.1 Weigh 0.50 gms of dried sediment into a 125 mL Erlenmeyer flask. Record sample ID and date.
- 4.2 Pipette 1.0 mL of Po-208 standard into flask. Check the delivery of the pipette before use. Record the activity of the standard and the date.
- 4.3 Add 50 mL of 6 N Hydrochloric Acid (1:1, water: Conc. Acid always add the acid slowly to the water with mixing) to the flask. Add 1 mL of 30% Hydrogen Peroxide and 1 drop of Octanol.
- 4.4 Place the flask on a hot plate and heat to 90-95°C. Heat for 30 min. and remove from the hot plate and cool slightly. Add one drop of octanol and 1 mL of 30% hydrogen peroxide, if the samples foam vigorously add more octanol. Return the samples to heat for 30 min. Repeat the addition of peroxide at least two more times. If the samples continue to foam add additional peroxide until foaming subsides. Continue to heat for a total of four hours.
- 4.5 Remove the samples from heat, cover with a watch glass, and let stand over night.
- 4.6 Label the back of a copper disk with a water proof marker, spray with urethane, use three light coats. Label should contain sample ID (Lake, Station and Depth)

5.0 Filtration

- 5.1 Filter the sample through a Whatman No. 42 filter paper into another Erlenmeyer flask. A Buchner funnel attached to vacuum is best for this step.
- 5.2 Rinse the digestion flask three times with small portions of Type 1 water and add to the filter.

6.0 Plating

Po-210 Plating Procedure-Caution!! This procedure uses Concentrated Hydrochloric acid and 30% Hydrogen Peroxide both of which can cause severe burns - Safety glasses, protective gloves and a lab coat must be worn while performing this procedure.

- 6.1 Place the flask on a hot plate, carefully reduce the volume to approx. 5 mL. Do not let the sample go to dryness. Cool.
- 6.3 Measure the pH, adjust to between 0.5 and 1.0, use HCl or NaOH.
- 6.4 Add 0.1 to 0.2 gms of Ascorbic acid to each sample and dissolve. The ascorbic acid is added to form a complex with ferric iron, thereby preventing its possible interference with the Po-210 plating.
- 6.5 Transfer the sample to a 125 mL plastic bottle, rinse the flask three times.
- 6.6 Polish the previously labeled disk with polishing, rub it off with a Kimwipe.

- 6.7 Add the disk to the sample in the plastic bottle, make sure the polished side is up. Cap the bottle.
- 6.8 Place the bottle in a 95°C oven. Heat overnight.
- 6.9 Remove the samples from the oven. To remove the copper disk, tighten the cap on the bottle and turn it upside down, the copper disk should be in the cap. Slowly turn the bottle over, the disk should remain in the cap.
- 6.10 Remove the disk, rinse with Type 1 water then with ethanol, pat dry (do not rub), place in a plastic zip lock bag. The bag should be labeled with the sample ID, date digested and the date plated.

